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Investigation of Performance Characteristics of Diesel Engine Fuelled with B5 Diesel

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Abstract: The investigation of performance diesel engine was investigated by using Yanmar 1-cylinder diesel engine. Standard experimental procedures were conducted. The B5 diesel fuel was used and engine fuel consumption, brake fuel consumption, brake power and torque were compared. Different engine load was set at different engine speed. Increasing engine speed from 1400 RPM to 1700 RPM, will increase fuel consumption, brake power and torque, while reduced brake specific fuel consumption with every constant load of 2 kW,4 kW and 6 kW. Increasing engine load from 2 kW to 6 kW, will increase fuel consumption, brake power and torque, while brake specific fuel consumption will reduce with every constant engine speed of 1400 RPM, 1500 RPM, 1600 RPM and 1700 RPM.
Keywords: Diesel Engine, B5 Diesel, Fuel Consumption, Brake Fuel Consumption, Brake Power, Torque

I. INTRODUCTION

The reputation of the diesel engine as a noisy, smoke and slow generating station has change due to modern diesel technology which allows one to combine the inherent low fuel efficiency with excellent driving performance and low-emission features. (Mccallan et al., 1999; Tatur et al., 2007; Jacobs, 2005). The term "diesel engine" is used throughout the world to designate two- or four stroke compression ignition engines with airless fuel injected. Such engines produce greater power and are adaptive to wide range of fuels (Kowalewicz and Wojtyniak, 2005). The pressures for substantial improvements in the performance of internal combustion engines have become significant, but emission control requirements have made it more difficult to improve engine fuel consumption. Since, then a lot of work is being done on the use of alternative fuels to diesel fuel (Kowalewicz and Wojtyniak, 2005; Hansen et al., 1989; Czerwinski, 1994; Machancon et al., 2001; Lakshmi et al., 2007).

Hansen et al. (1989) investigated the combustion of ethanol and blends of ethanol with diesel fuel. The effects of the addition of ethanol to diesel fuel were observed to be increased ignition delay, increased rates of premixed combustion, increased thermal efficiency, and a reduction in exhaust smoke. Czerwinski (1994) used rapeseed oil, ethanol and diesel fuel blend and compared the heat release curves with diesel fuel. It was observed that the addition of ethanol caused longer ignition lag at all operating conditions.

One of the most important characteristics of diesel fuel is its ability to auto ignite, a characteristic that is quantified by a fuel's cetane number or cetane index, where a higher cetane number or index means that the fuel ignites more quickly (Cngur and Altiparmak, 2003). Nigerian diesel fuel typically has a cetane number in the low 40s and European diesel fuel typically has a cetane number in the low 50s (NNPC, 2007). The Nigerian kerosene has an average cetane number of 49 (NNPC, 2007). In comparison the cetane number for diesel fuel ranges from 40 to 52. This implies that a careful blending of kerosene and diesel fuel could result in a blending of fuel of which some numbers are at the top of the range. The cetane number of a fuel indicates the self-igniting capability of the fuel and has a direct impact on ignition delay. The higher the cetane number, the shorter the ignition delay and vice versa (Cngur and Altiparmak, 2003). The objective of this study is to investigate the performance characteristic of single cylinder diesel engine with different parameters such as fuel consumption, brake specific fuel consumption, power brake and torque. The engine was fueled by B5 diesel which is 5% of bio-diesel and 95% of petro diesel. The engine will be loaded with 3 different load which is 2kW,4kW and 6kW. Different engine speeds will set for the load given which is 1400 RPM,1500 RPM, 1600 RPM and 1700RPM. The engine Torque and the time for 20 millilitre B5 diesel consume by the engine will be recorded.

II. EXPERIMENT SET UP

The experiment was conducted by a horizontal single cylinder naturally aspirated four stroke air cooled engine. The engine specification was shown on Table 1. In order to collect the experimental data, the single cylinder diesel engine and dynamometer testbed were used as shows in Fig. 1. The single cylinder diesel engine was connected to the dynamometer. The dynamometer will give the load to the engine. All the parameters needed in this experiment like torque and engine speed can be read on the display of dynamometer testbed. The diesel fuel will be filled in the tank and the volume of diesel fuel needed in this experiment can be measured by using fuel flow meter. The speed of the engine will be control by throttle lever at the engine.

Single cylinder diesel engine was started by detach the starting handle from the mounting fixture and put on starting shaft. 2 kW of load to the engine and engine speed of 1400 RPM was set. The B5 diesel fuel was used in this experiment and set to volume 20 millilitre. The time of fuel consumption was recorded until the 20 ml of B5 diesel engine finished.

Table 1
Diesel Engine Specification

Particulars	Specifications
Make and Model	Yanmar TF90M/ME
Continuous Rating Output	8.5hp@2400rpm
Cylinder	1
Combustion	Direct Injection
Cooling System	Water
Bore x Stroke	85 x 87 mm
Displacement	0.493 litre
Lenght	662 mm
Width	330.5 mm
Height	496 mm

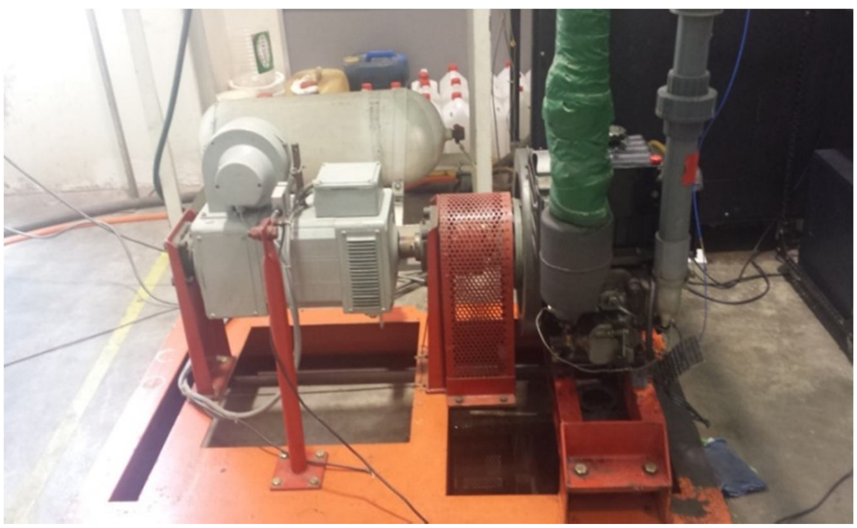

Fig. 1 Single Cylinder Diesel Engine

The torque reading was taken on dyno meter test rig. The procedures were repeated by using the engine speed of 1500 RPM, 1600RPM and 1700 RPM respectively. The loads of engine were changed to 4kW and 6kW.Table 2 shows the speed and load that need to be set and the data that need to be collect in this experiment.

Table 2
Experimental Data

1400 RPM			1500 RPM			1600 RPM			1700 RPM		
2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW

III.RESULT AND ANALYSIS

Table 3 shows the results for 2 kW, 4 kW and 6 kW of load at different speeds which are 1400 RPM, 1500 RPM, 1600 RPM and 1700 RPM that was obtained from the experiment. The result shows that, the time for fully used 20 ml of fuel decreased as a speed increased. The result for torque, on the entire figure also shows increasing value at different load and speed.

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TABLE 3

Performance of Engine for 2 KW, 4 KW AND 6 KW of Load

	1400 RPM			1500 RPM			1600 RPM			1700 RPM		
	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW
Time (s)	144	82.8	67.2	138	77.4	63	130.8	72.6	57	122.4	66	51.5
Torque (Nm)	6.1	14.7	21.2	6.6	15.7	22.4	6.9	16.7	23.4	7.4	17.8	25

The brake power can be calculated by using Eq.1 and the result is shown in Table 4.

$$\dot{W}_b = (2\pi N*\tau) / 60 \qquad \text{Eq. 1}$$

Where

$\dot{W}_b$ = *brake power (kW)*

N = *RPM*

τ = *torque*

Table 4

Results of Brake Power at Different Engine Speed

	1400 RPM			1500 RPM			1600 RPM			1700 RPM		
	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW
Torque (Nm)	6.1	14.7	21.2	6.6	15.7	22.4	6.9	16.7	23.4	7.4	17.8	25
Brake Power (kW)	0.89	2.15	3.10	1.03	2.46	3.51	1.15	2.79	3.92	1.31	3.16	4.45

From Eq.2, the value of fuel consumption can be calculated and from the result, the specific fuel consumption also can be determined by using Eq.3. The result of fuel consumption and specific fuel consumption are shown in Table 5.

$$\dot{m}f = (20 \text{ x } 10\text{-}6 * \rho)/(time\ (sec)) = kg/sec \qquad \text{Eq.2}$$

Where

$\dot{m}f$ = *mass flow rate of fuel*

ρ = *Density of biodiesel B5*

$$bsfc = (\dot{m}f)/\dot{W}b \qquad \text{Eq.3}$$

Where

$bsfc$ = *brake specific fuel consumption*

$\dot{m}f$ = *mass flow rate of fuel*

$\dot{W}b$ = *brake power (kW)*

TABLE 5

Fuel Consumption and Brake Specific Fuel Consumption

	1400 RPM			1500 RPM			1600 RPM			1700 RPM		
	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW	2kW	4kW	6kW
Fuel consumption ($x10^{-4}$) (Kg/sec)	1.2	2.1	2.62	1.28	2.27	2.79	1.35	2.42	3.09	1.44	2.67	3.42
Brake specific fuel consumption (Kg/kW.hr)	0.49	0.35	0.30	0.44	0.33	0.28	0.41	0.31	0.28	0.39	0.30	0.27

IV. DISCUSSION

From the experiment, the relationship between fuel consumption and brake specific fuel consumption with engine speed for 2 kW, 4 kW and 6 kW of load are shown as Fig. 2. Fig. 2 shows the increasing value of fuel consumption for load of 2 kW, 4 kW and 6 kW with increasing engine speed from 1400 RPM to 1700 RPM. This is because of the friction losses in the engine. This is true because, at low engine speed the longer time per cycle allows more heat loss, therefore fuel consumption goes up (Pulkrabek, 2014).

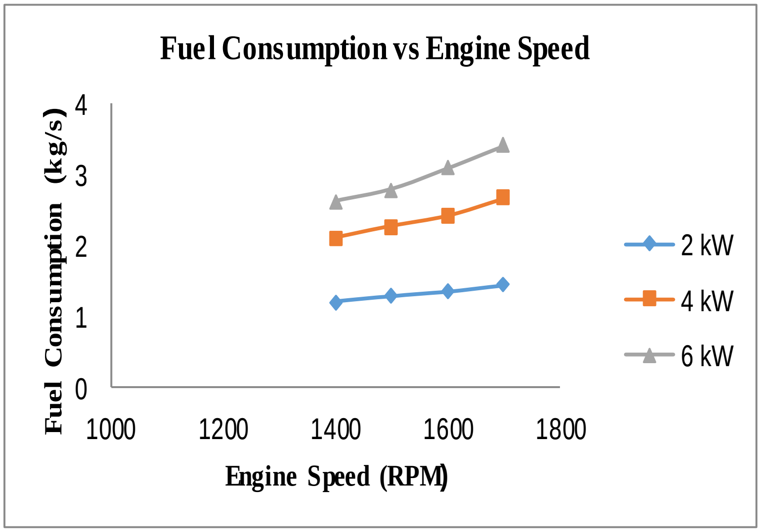


Fig. 2 Relation between fuel consumption and engine speed

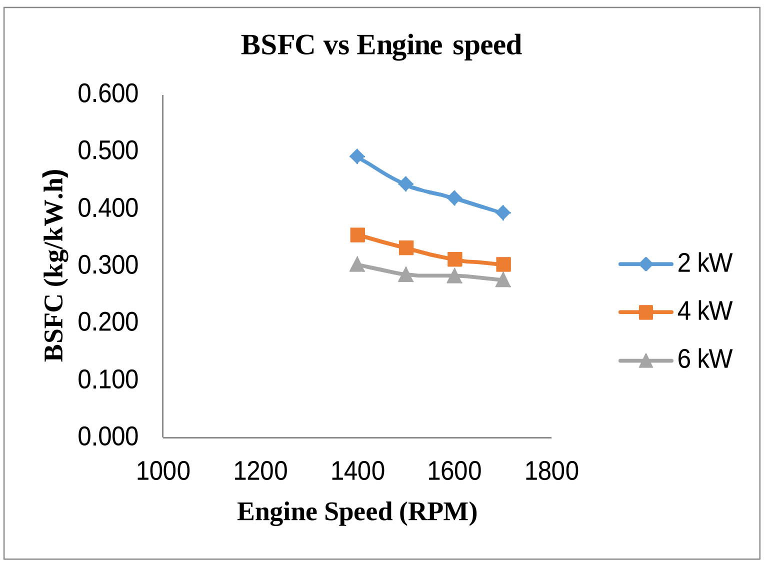


Fig. 3 Relation between brake specific fuel consumption and engine speed

Fig. 3 shows the relationship between brake specific fuel consumption and engine speed for load of 2 kW, 4 kW and 6 kW. The relationship shows that the value of brake specific fuel consumption decrease as engine speed increase. This is because of the shorter time for heat loss during each cycle (Pulkrabek, 2014). This finding was supported by experiment done by (Iz, 2005). (Iz, 2005) find that, the brake specific fuel consumption of diesel engine will decrease in the increasing of engine speed. (Iz, 2005) did the experiment by using single cylinder diesel engine at speed range between 1000 RPM to 2000 RPM at 100% load. Fig. 4 shows the comparison between (Iz, 2005) and the result at 6 kW of load.

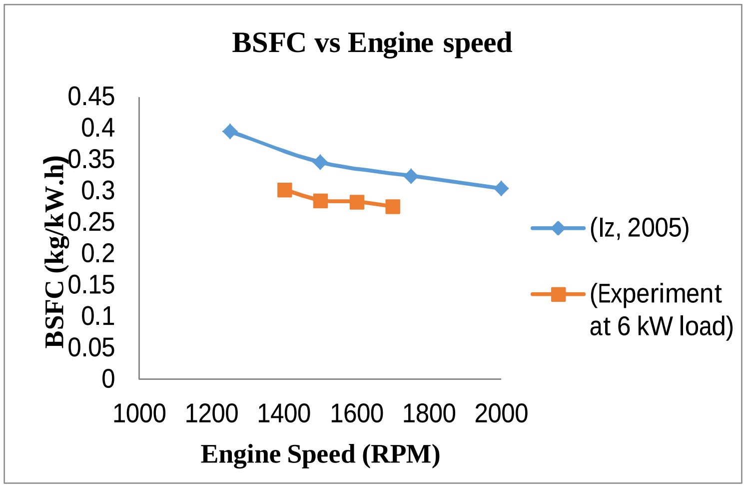


Fig. 4 Comparison between (Iz, 2005) and experiment

The brake power with variation of engine speed and load was shown in Fig. 5. From Fig. 5, the brake power was increase with the increase of engine speed. This is true for all the load applied, 2kW, 4kW and 6kW. The brake power of 6 kW load is 29.3% higher than brake power of 4 kW load and 70.7 % higher than the brake power of 2 kW of load. The graph will increase until it reaches at the maximum value and then it will have predicted decrease until engine speed of 2400 RPM. This is because friction losses increase with speed and become the dominant factor at very high speed (Pulkrabek 2014). This result was supported by the experiment done by (Liaquat et al., 2013) that blend 5% of coconut oil to 95% of diesel fuel (CB5). The brake power will increase as engine speed increase until it reaches the maximum value at 2200 RPM and then reduce until engine speed at 2400 RPM.

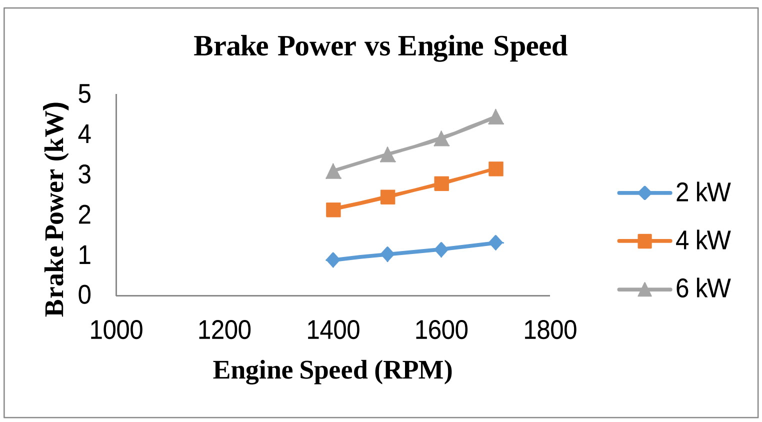


Fig. 5 Brake power vs Engine speed at different loads

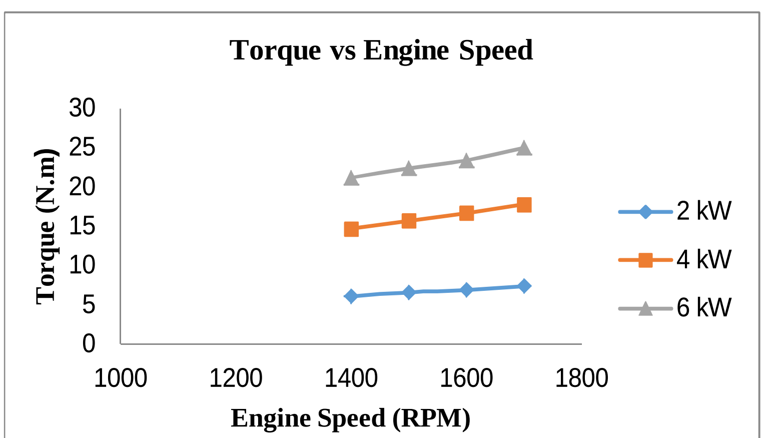


Fig. 6 Torque vs Engine Speed at different loads

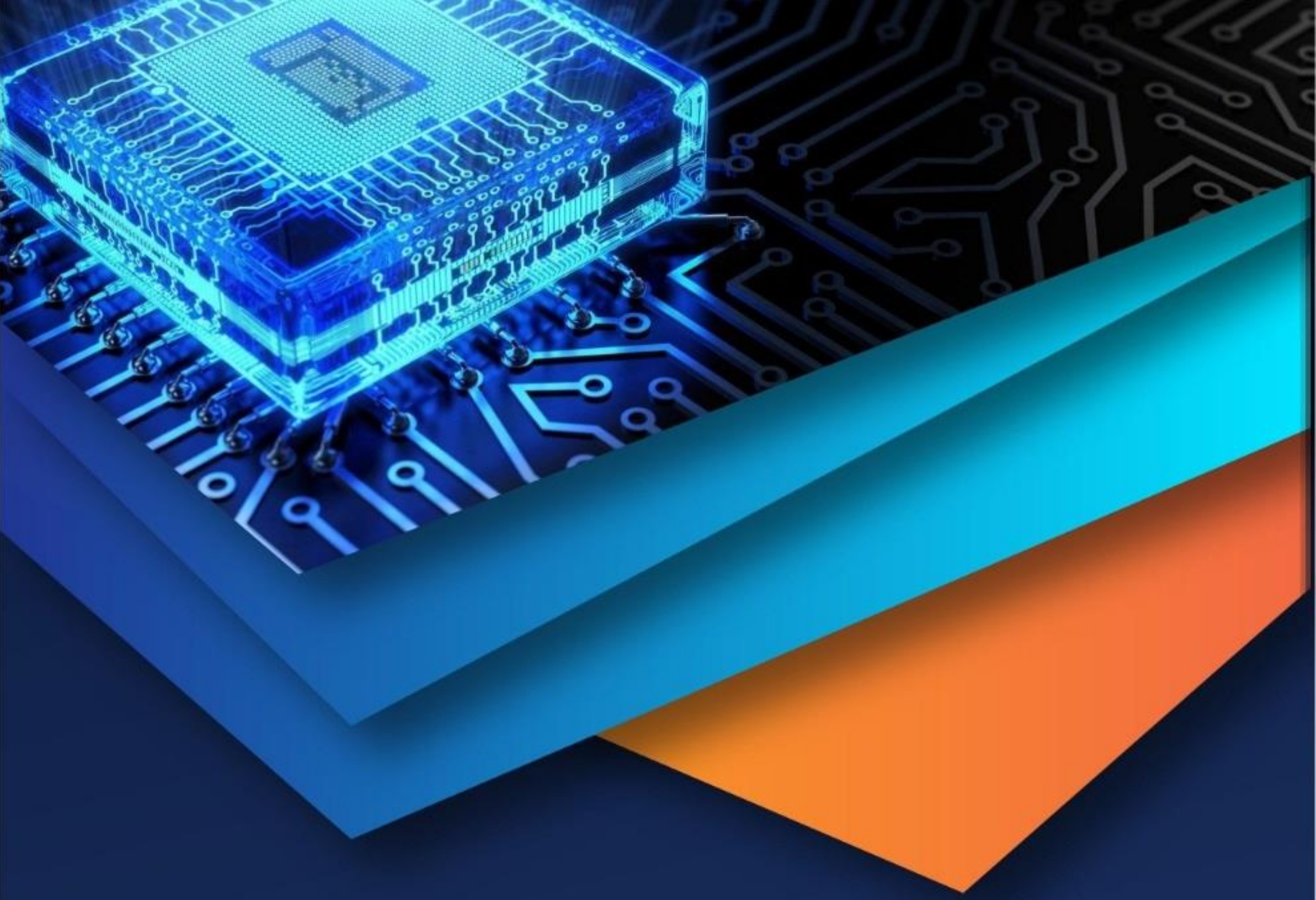
Fig. 6 shows the graph of relationship between torque and speed of engine for indicated load of 2 kW, 4 kW and 6 kW. For 2 kW of indicated load, the torque increased from 6.1 Nm to 7.4 Nm at speed of 1400 RPM to 1700 RPM. Thus, from the result the point of MBT speed is 7.4 Nm at engine speed 1700 RPM. At 4 kW of indicated load, the torque also increased from 14.7 Nm to 17.8 Nm which is higher compared to 2 kW of indicated load. From the result, the point of MBT speed is 17.8 Nm at engine speed 1700 RPM. While at 6 kW of indicated load, the torque increased higher than 2 kW and 4 kW of indicated load. The torque at 6 kW of indicated load was from 21.2 Nm to 25 Nm at 1400 RPM to 1700 RPM. Thus, from the result the point of is 25 Nm at engine speed 1700 RPM. **(**Liaquat et al., 2013) find the same relation between torque and engine speed. By using 5 % of coconut oil that blend into 95% of diesel fuel, the relationship between torque and engine speed shows that, torque was increase as engine speed increase until it reaches the maximum value at 2200 RPM and then decrease until engine speed reach 2400 RPM.

V. CONCLUSIONS

The performance characteristic of 1-cylinder 4 stroke diesel engine has been analyzed and engine characteristic with difference parameters such as fuel consumption, brake specific fuel consumption, power brake and torque have been compared with different engine load and engine speed. With the increase engine speed from 1400 RPM to 1700 RPM it will increase fuel consumption, brake power and torque, while reduced brake specific fuel consumption with every constant load of 2 kW,4 kW and 6 kW. With increase in load from 2 kW to 6 kW it will increase fuel consumption, brake power and torque, while brake specific fuel consumption will reduce with every constant engine speed of 1400 RPM, 1500 RPM, 1600 RPM and 1700 RPM.We can see that all parameters which effect on performance of engine will increase until it reaches at maximum value and then decrease until it reaches 2400 RPM of engine speed. For many diesel engine (CI engine) maximum brake power occur at about one and half times the speed of maximum torque we can get on higher torque engine with engine speed less than

REFERENCES

[1] Czerwinski, J. 1994. Performance of HD-DI-Diesel Engine with addition of Ethanol and Rapeseed Oil, SAE Technical Paper No. 94-0545
[2] Iz, O. D. E. N. (2005). Experimental Performance Analysis of Biodiesel, Traditional Diesel and Biodiesel with Glycerine, 29, 89–94.
[3] Jacobs, T.; Bohac, S.; Assanis, D. and Szymkowicz, P. 2005. Lean and Rich Premixed Compression Ignition Combustion in a Light-Duty Diesel Engine, SAE Technical Paper No. 2005-01-0166.
[4] Kowalewicz, A. and Wojtyniak, M. 2005. Alternative Fuels and their Application to Combustion Engines, Journal of Automobile Engg. 219(1): 103-125.
[5] Lakshmi, G.; Narayana, R.; Sampath, S. and Rajagopal, K. 2007. Experimental Studies on the Combustion and Emission Characteristics of a Diesel Engine Fuelled with used Cooking Oil, Methyl Ester and its Diesel Blends, Intern. J. Applied Science, Engg and Techn.4 (2): 64-70.
[6] Liaquat, a. M., Masjuki, H. H., Kalam, M. a., Fattah, I. M. R., Hazrat, M. a., Varman, M., Shahabuddin, M. (2013). Effect of Coconut Biodiesel Blended Fuels on Engine Performance and Emission Characteristics. Procedia Engineering, 56, 583–590. doi: 10.1016/j.proeng.2013.03.163
[7] Machancon, H. T. C.; Matsumoto, Y.; Ohkawara, C.; Shiga, S.; Karasawa, T. and Nakamura, H. 2001. The Effect of Coconut Oil and Diesel Fuel Blends on Diesel Engine Performance and Exhaust Emissions, JSAE Review. 22: 349-355.
[8] Mccallan, R.; Couch, R.; Leonard, A.; Brady, M.; Salari, K.; Rutledge, W.; Ross, J.; Storms, B.; Heineck, J. T.; Driver, D.; Bell, J. and Zilliac, G. 1999. Process in Reducing Aerodynamic Drag for Higher Efficiency of Heavy Duty Trucks (Class 7-8), SAE Technical Paper No. 1999-01-2238. Nigerian National Petroleum Corporation (NNPC). 2007. Warri Refining and Petrochemical Co. LTD Technical Report. 4: 87.
[9] Obodeh, O. and Ezimokhai, A. A. 2008. Investigation of Emissions from Diesel Engine Fuelled with Diesel-Kerosene Blends, Intern. J. Pure and Applied Sci. 2(2): 42-46.
[10] Obodeh, O., Isaac, F. O., & State, E. (2011). Investigation of Performance Characteristics of Diesel Engine Fuelled with Diesel-Kerosene Blends, 2(2), 318–322.
[11] Tatur, M.; Laermann, M.; Koehler, E.; Tomazic, D.; Holland, T.; Robinson, D.; Dowell, J. and Price, K. 2007. Development of an Emissions Control Concept for an IDI Heavy-Duty Diesel Engine Meeting 2007 Phase-In Emission Standards, SAE Technical Paper No. 2007-01-0235.
[12] Willard W. Pulkrabek, 2014, Engineering Fundamental of the Internal Combustion Engine 2nd Edition, Pearson New International.



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